KU LEUVEN

TECHNOLOGIECAMPUS DIEPENBEEK

KHLim
MOVING MINDS

Ongoing research to enhanced physico-chemical soil remediation techniques

Braeken, L., Sniegowski K., Vanhecke M., D'Huys P-J.

Situation of the research group

KHLim QUADRI
Quality driven

Lab$_4$U
Onderzoek en dienstverlening
Chemische en biochemische analyses
Milieu- en procestechnologisch advies
methodeontwikkeling

- Faculty of Industrial Engineering – University of Leuven, Technology campus Diepenbeek, Belgium
- Department of Industrial Science and Technology – Catholic University college (KHLim), Belgium

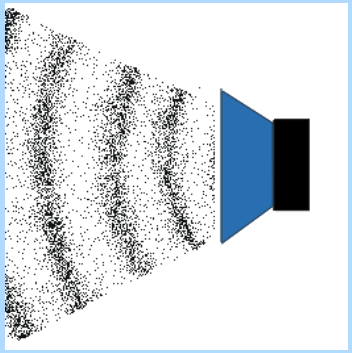
KHLim
MOVING MINDS

Aim:
Technology Transfer from research to the field

KU LEUVEN

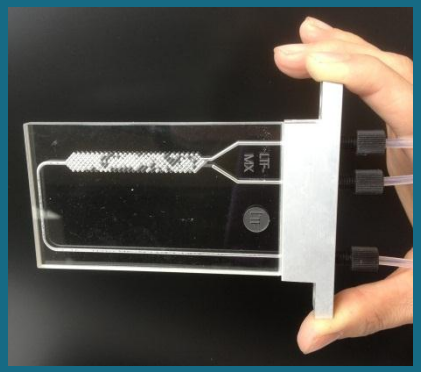
Research topics of Lab_4U…

Cleantech



Acoustic processing

Biotechnology



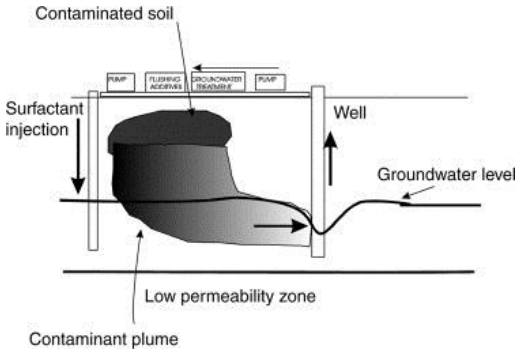
Flow chemistry

KU LEUVEN

Research overview

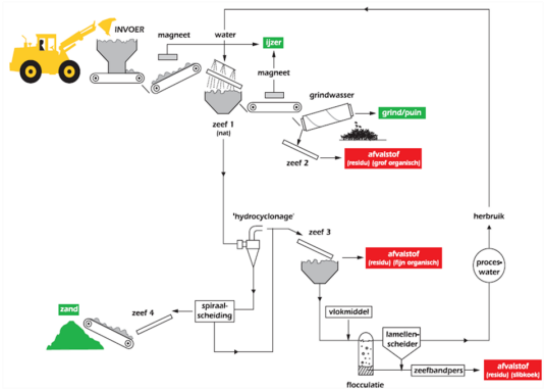
1. SOIL FLUSHING

Increase the water solubility of mineral oil with solubility enhancing additives to accelerate the pump & treat process



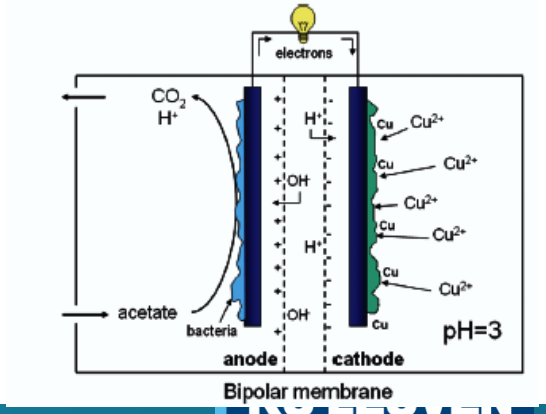
2. SOIL WASHING

Enhance leaching of organic pollutants and metals from soil by the combination of additives and acoustic energy



3. MICROBIAL FUEL CELLS

Using microbial activity to remove metals from waste water



1. Soil flushing

- ✓ Increase solubility
- ✓ Oxidation of organic contaminants

Green chemicals

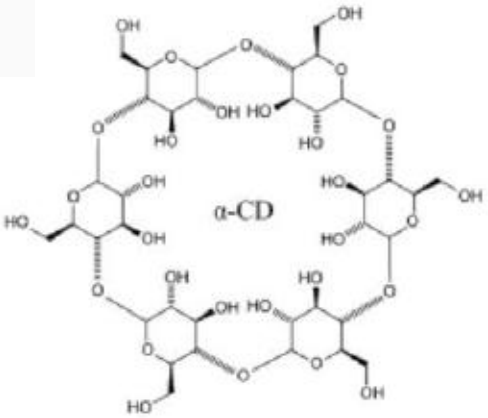
Conditions:

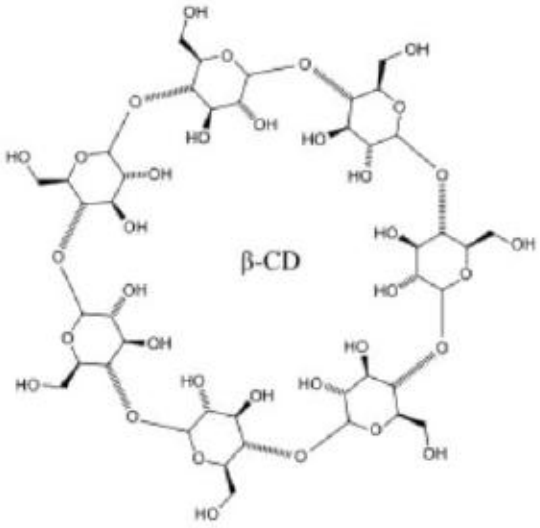
- ➢ Low toxicity
- ➢ Biodegradable
- ➢ Recyclable
- ➢ Low cost price

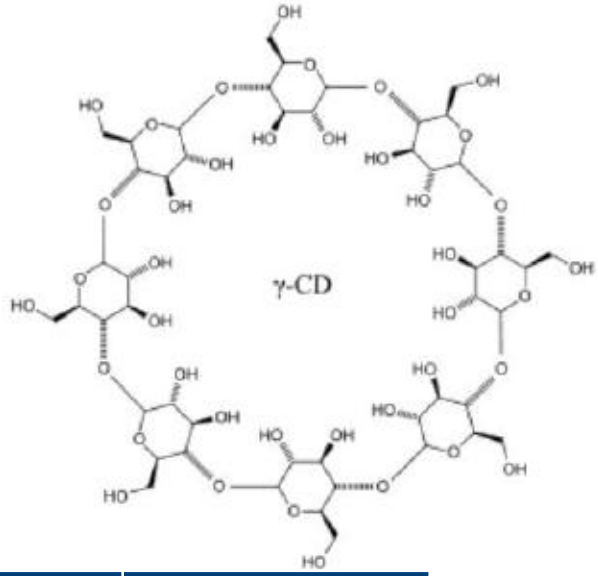
KU LEUVEN

1. Soil flushing

Cyclodextrin:



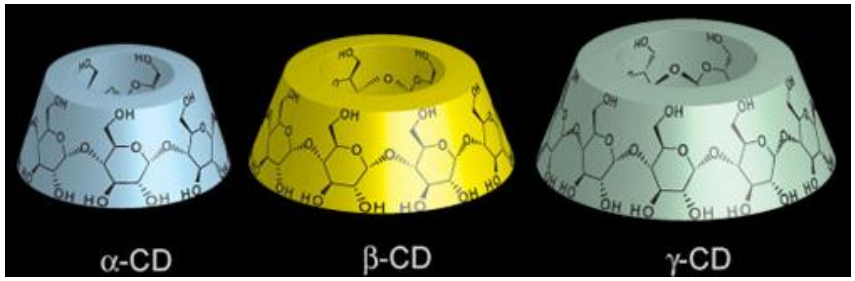




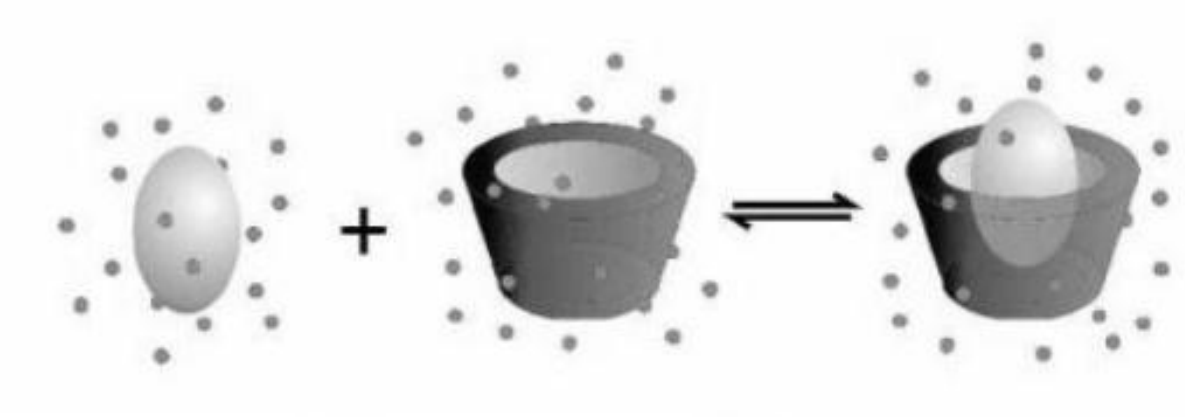
	α-Cyclodextrin	β-Cyclodextrin	γ-Cyclodextrin
No. of glucose units	6	7	8
Cavity diameter (nm)	0.47	0.60	0.75
Heigth of torus (nm)	0.79	0.79	0.79

KU LEUVEN

1. Soil flushing



Harada Laboratory, OSAKA UNIVERSITY

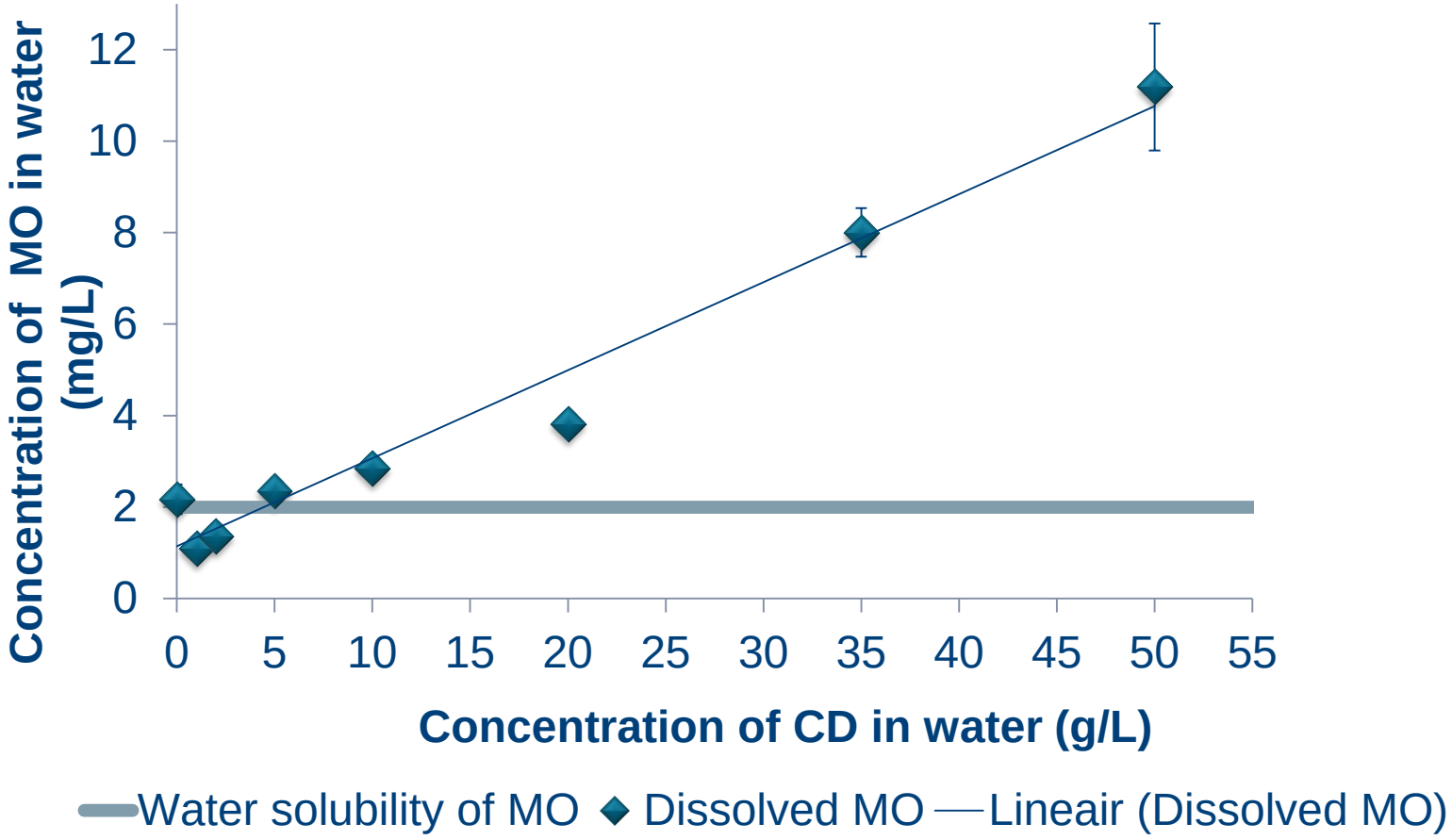


Host molecule
e.g. mineral oil

Cyclodextrin

H_2O molecule

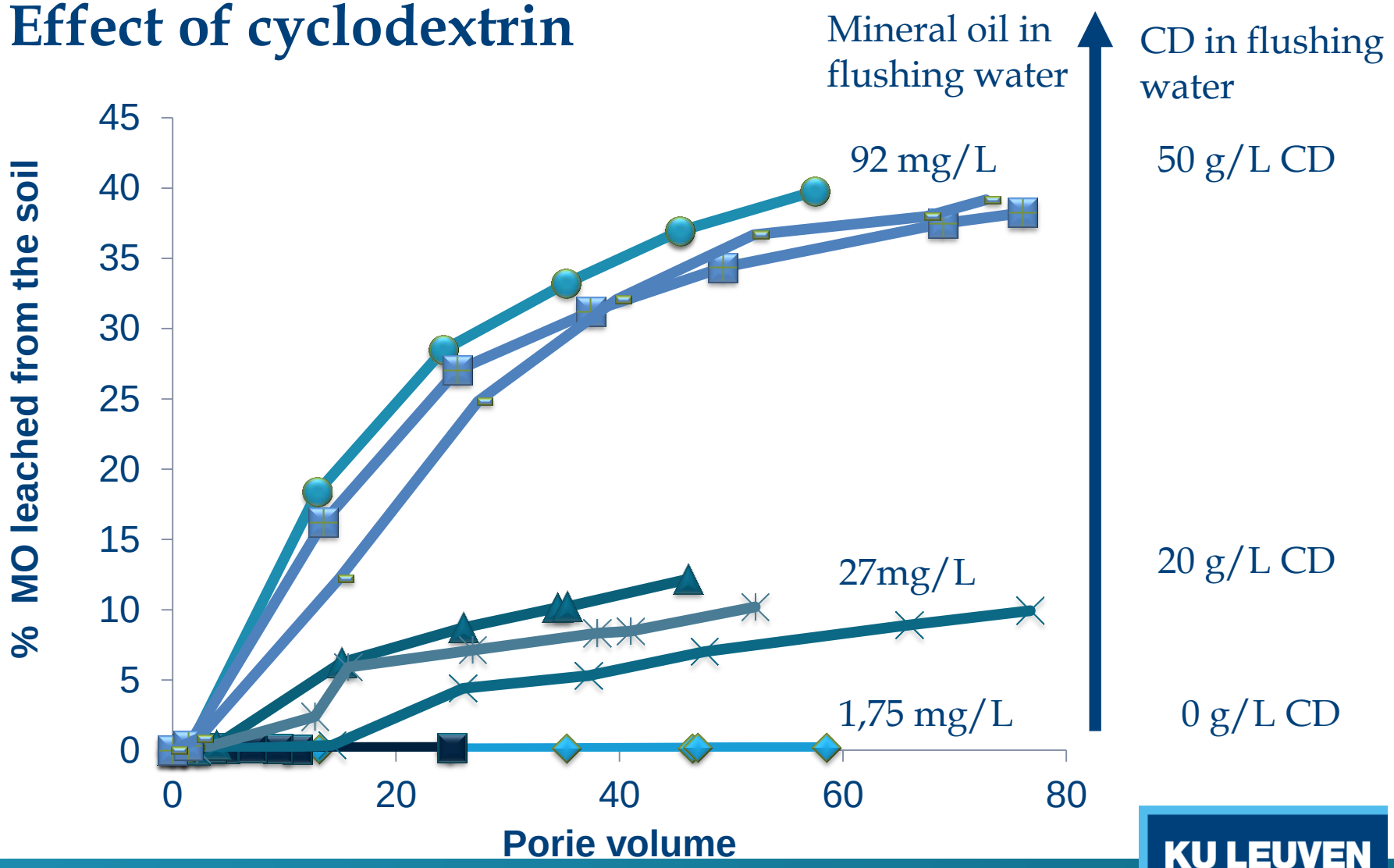
1. Soil flushing



KU LEUVEN

1. Soil flushing

Effect of cyclodextrin

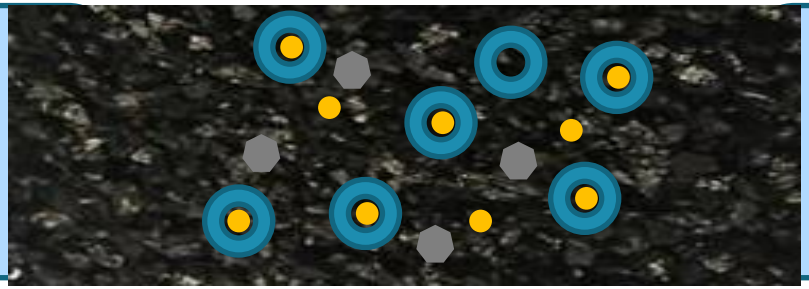


KU LEUVEN

1. Soil flushing

Active carbon to reuse cyclodextrin

Principle:



flow

active carbon

cyclodextrin

mineral oil

dissolved organic matter

KU LEUVEN

1. Soil flushing

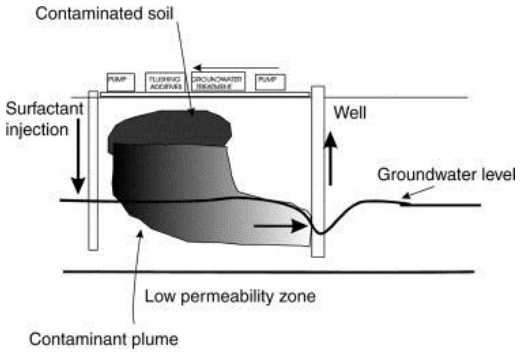
Despite high potential:
high efficiency, low toxicity, biodegradable, easy to recycle

- No pilotscale testing due to high cost price of cyclodextrin
- No inexpensive, technical grade cyclodextrine available

Research overview

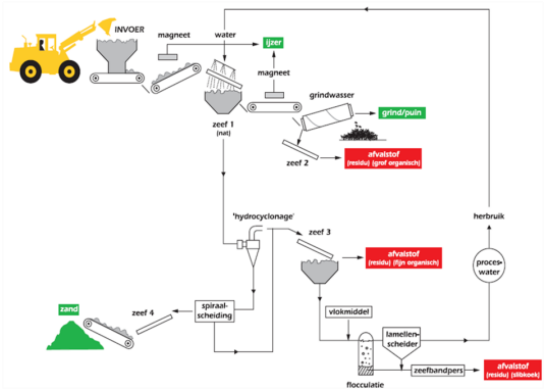
1. SOIL FLUSHING

Increase the water solubility of mineral oil with solubility enhancing additives to accelerate the pump & treat process



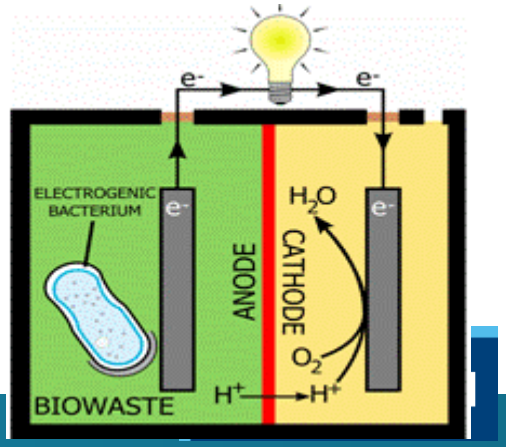
2. SOIL WASHING

Enhance leaching of organic pollutants and metals from soil by the combination of additives and acoustic energy



3. MICROBIAL FUEL CELLS

Using microbial activity to remove metals from waste water



2. Soil washing

- ✓ Increase solubility
- ✓ Oxidation of organic contaminants

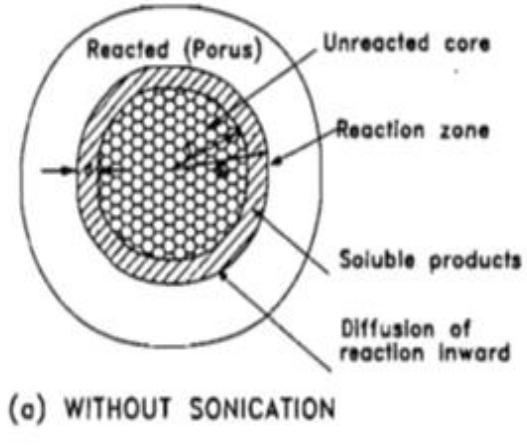
Green chemicals

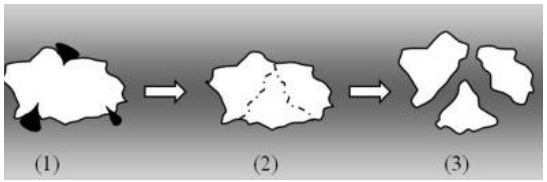
Additional conditions:

- ➢ No foaming

Synergetic effect?

- → Less additive?
- → Less energy?
- → More leaching?
- → Faster leaching?

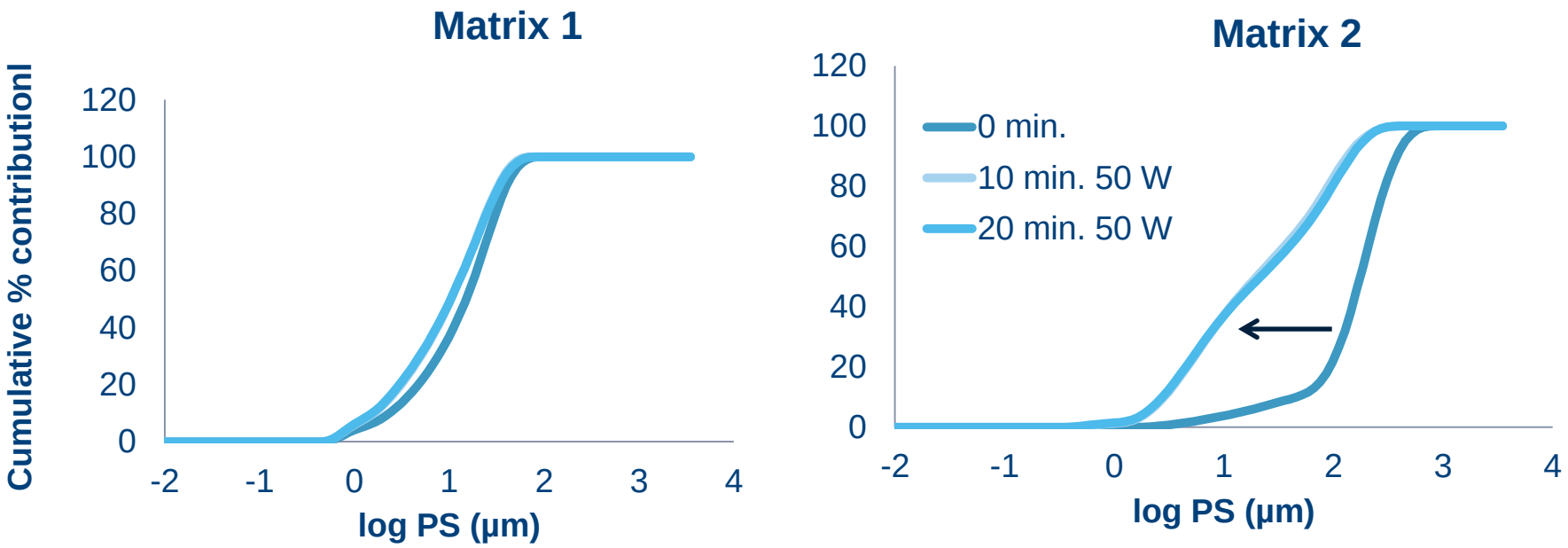




KU LEUVEN

2. Soil washing

Effect of ultrasound on particle size:



Effect depends on initial particle size distribution

KU LEUVEN

2. Soil washing

Matrix:
soils, bottom ashes, solid wastes from landfill
mining, metal slag recycling facility…

Organic contaminants:
mineral oil (diesel), (PAH's)

Additives:
oxidative or solubility enhancer

Product
Laboclean FLA
Oxygel
Calciumperoxide
Caprylyl/Capryl Glucoside
Sorbitan Sesquioctaloate
1,2-Propane diol
Sophorolipids

Inorganic contaminants:
Cu, Zn, Cd, Cr, Pb

Additives:
Complexing agents

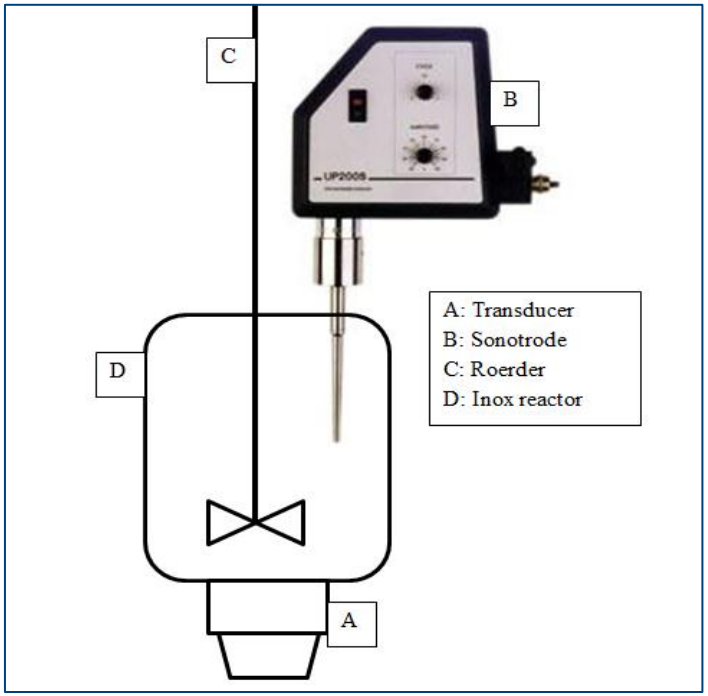
Product
Laboclean FLA
Citric acid
Diammoniumcitric acid
Oxalic
Baypure
EDTA (reference)

KU LEUVEN

2. Soil washing

1. Lab-scale leaching tests

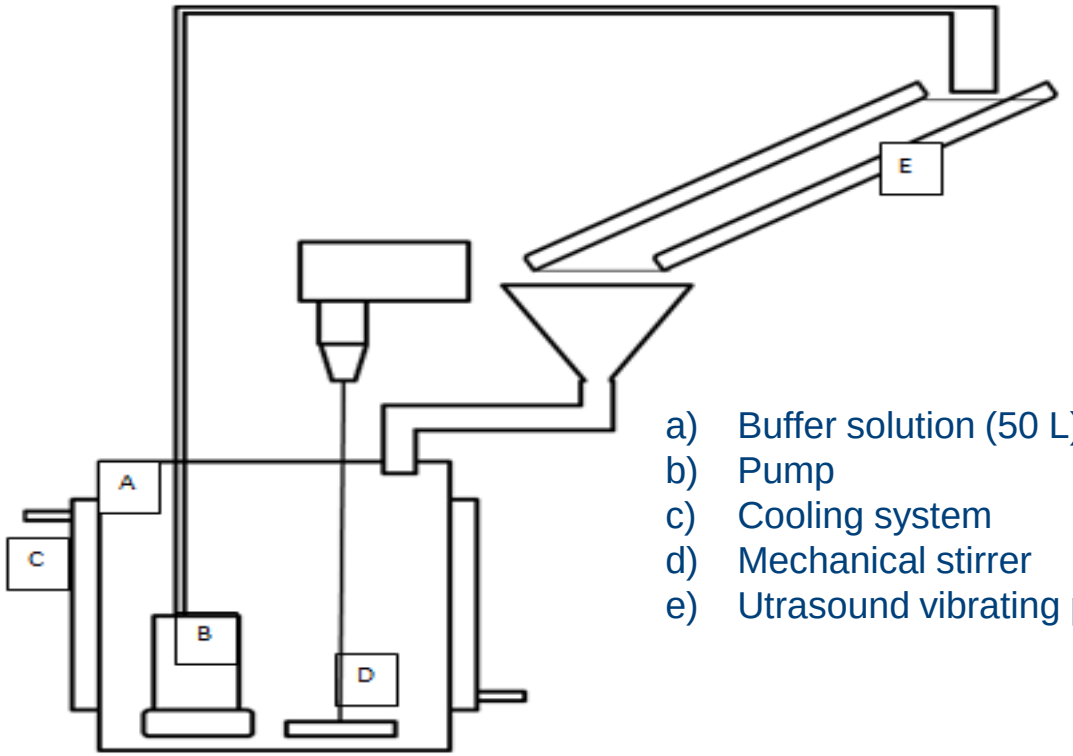
Efficiency additive → Synergetic effect with US?



KU LEUVEN

2. Soil washing

2. Semi-pilot tests



a) Buffer solution (50 L)
b) Pump
c) Cooling system
d) Mechanical stirrer
e) Utrasound vibrating plate

KU LEUVEN

2. Soil washing

- Efficiency?
- Economical interesting

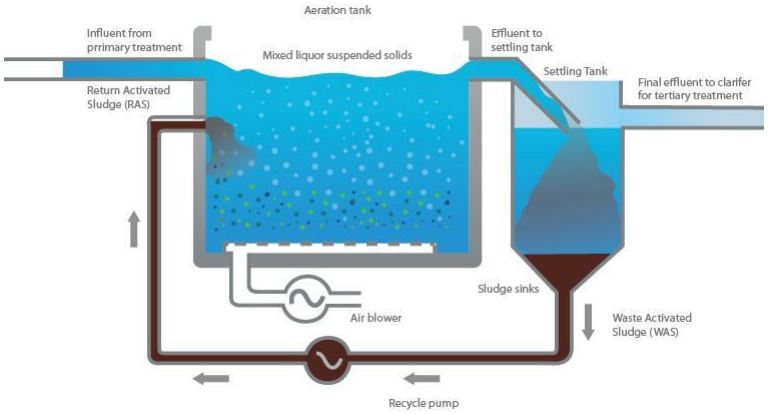
KU LEUVEN

2. Soil Washing

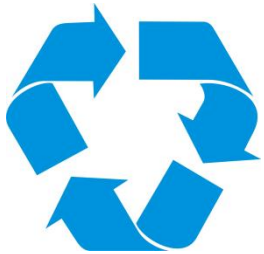
HOW ABOUT THE WASHING WATER ?

→ **Organic contaminants:**

→ Effect on the microbial population of the water purification system (additives, elevated organic material,…)



→ Recovery of the additive possible?



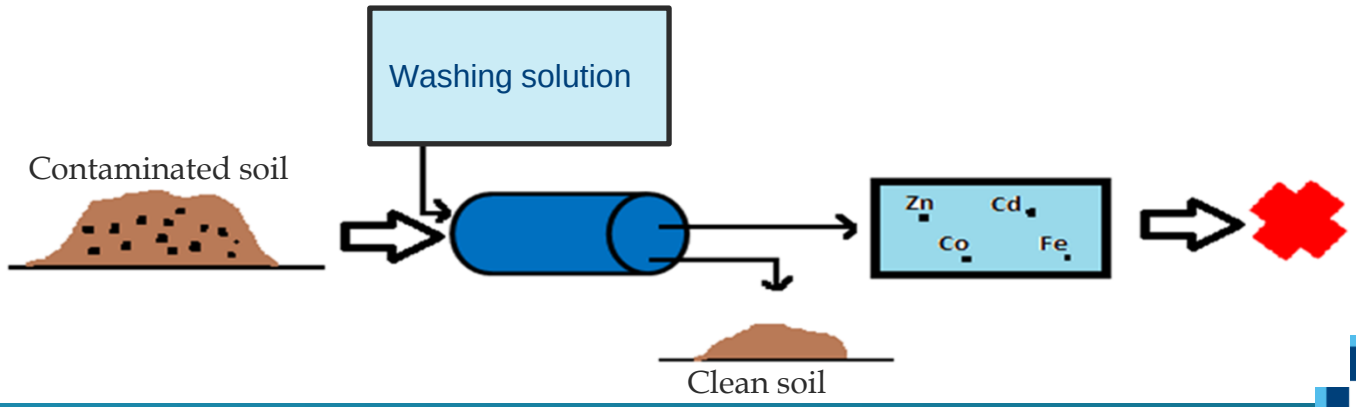
KU LEUVEN

2. Soil Washing

HOW ABOUT THE WASHING WATER ?

→ **Inorganic contaminants:**

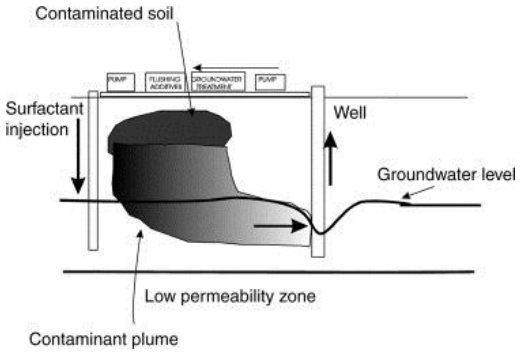
- → How to remove the metals from the water?
- → The effect of the additives on the removal technique?
- → Recovery of the additive?
- → Recovery of the metals?



Research overview

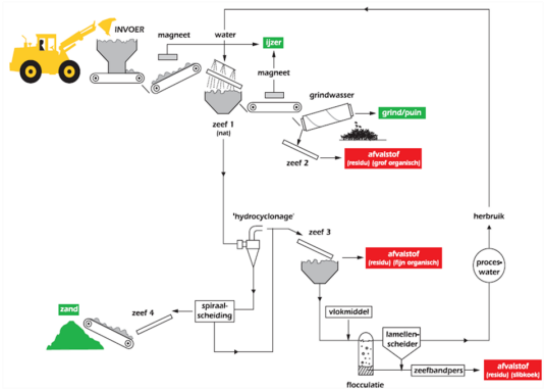
1. SOIL FLUSHING

Increase the water solubility of mineral oil with solubility enhancing additives to accelerate the pump & treat process



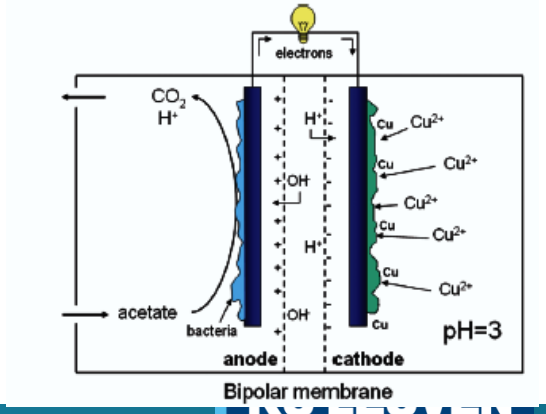
2. SOIL WASHING

Enhance leaching of organic pollutants and metals from soil by the combination of additives and acoustic energy



3. MICROBIAL FUEL CELLS

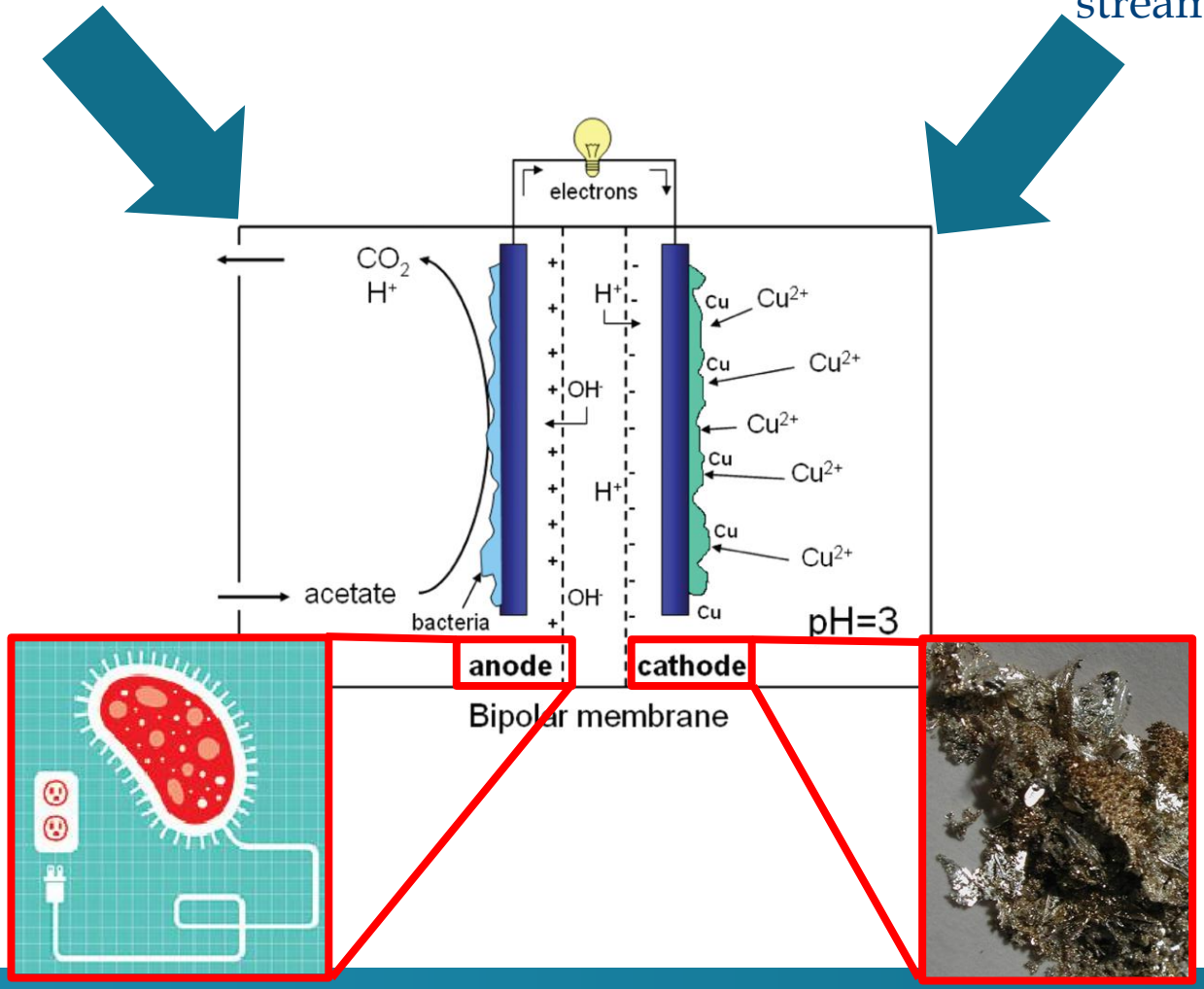
Using microbial activity to remove metals from waste water



3. Microbial fuel cell

Onorganic waste stream

Inorganic waste stream



KU LEUVEN

3. Microbial fuel cell

Advantages:

- ✓ Simultaneously waste water treatment and recovery of metals
- ✓ Lower energy input than for a classic elektrolysis

Research:

- ✓ Efficiency in real-life waste streams?
- ✓ Recovery efficiency?
- ✓ Purity of the metals?
- ✓ Energy input?
- ✓ Effect of additives ?

KU LEUVEN

New project opportunity

Remove metals from liquid streams with adsorbing agents

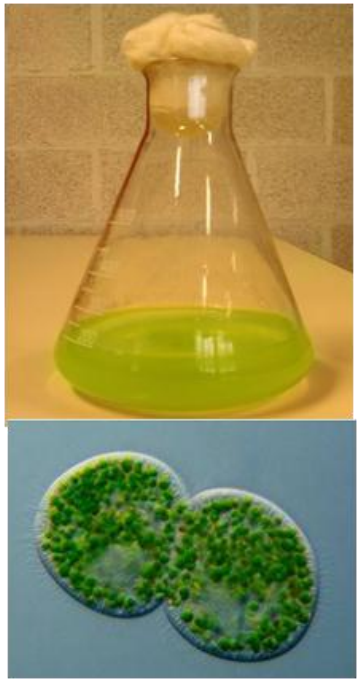
Industrial partners:

→ Liquid Waste streams with a metal contamination

→ Adsorbing agents

✓ Natural adsorbents
Ex. Biosorption by algae

✓ Adsorbents from waste streams
Ex. Waste water residuals (iron oxides)



KU LEUVEN

Ongoing research to enhanced physico-chemical soil remediation techniques

Leen Braeken
Kristel Sniegowski
Pieter-Jan D'Huys
Marina Vanhecke
Elke Gubbelmans
Jasper Peeten
Geert Janssen
Jordy Celis
Sonja Achten
Marleen Segers
Students from FIIW and IWT

KU LEUVEN